# XVI. NOTES FROM THE BENGAL FISHERIES LABORATORY, INDIAN MUSEUM.

## No. 2. On some Indian Parasites of Fish, with a note on Carcinoma in Trout.

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(Plates xxvi–xxviii).

CONTENTS.



The following paper deals with a variety of fish diseases, all of which are—with two exceptions—caused by parasites.

The "lice" which live on the skin of Bhekti are not more harmful than other lice which live on other animals. The "lice" which are described from Rohu are, however, much more dangerous than those found on Bhekti. In tanks and confined water-areas these parasites may cause great mortality amongst Rohu, and every fish in the tank may die.

The larval Trematodes which live in the skin and flesh of a number of fish are of some importance. Heavy infection most probably interferes somewhat with normal growth, and it is not

impossible that certain of these parasites may mature in the human intestine.

The "pox" recorded from *Rasbora daniconius* (Bengali "dankona") may become a very fatal disease when occurring in limited water-areas such as tanks.

The parasite from the abdomen of *Diagramma crassispinum* (a fish somewhat like the one known in Bengal as Khora Bhekti) is not of any commercial importance.

An epidemic of goitre amongst the trout at Naini Tal is of a serious nature, and if not kept in check will interfere greatly with the successful cultivation of this species.

A case of Glaucoma of the eye in a marine fish recorded in this paper is of pathological interest only.

### (1) A skin disease found on Rasbora daniconius.

(Plate xxvi, fig. 3).

Four specimens were collected by Capt. R. B. Seymour Sewell, B.A., I.M.S., from a stream near Katiwan, Mirzapore (U. P.), India.

In all, six cysts were found on the four fish in question. They were situated immediately below the scales, in the epidermis, and were milky-white, soft, flattened, and roughly oval in shape. The largest measured 1·1 mm. No pigment was present.

Preparations of the contents of these cysts showed that they contained Myxosporidia, or parasitic protozoa. The order Myxosporidia, Butschli, contains a series of parasites which occur in both fresh water and marine fish. They are usually found beneath the skin, as small wart-like nodules near the fins and on the gills. The parasite causing the well-known silkworm disease (*Glugea bombycis*) is closely related to the parasite recorded in the present paper. Representatives of the Myxosporidia have also been found in the urinary bladder and gall bladder of fishes, and they are also recorded as occurring in Crustacea, frogs, and crocodiles. At the present time over 60 species of fish are known to harbour parasites included in the order Myxosporidia and about 50 distinct species of parasites are recognized. In Europe epidemics amongst fish have frequently been traced to the presence of such parasites, although it appears that the mortality is not directly due to their presence, but to the presence of bacilli which develop within the cysts and give rise to ulcerations, which, discharging, not only kill the fish, but spread the disease.

Our parasites belong to the family Myxobolidae, Thelohan. The characters of this family are as follows:—

Spores with one or two polar capsules and with a peculiar iodinophilous vacuole in the sporoplasm (Minchin).

The genus *Myxobolus*, Butschli, 1882, to which our specimens belong, are characterized by the presence of one or two polar capsules and by the absence from the spore-membrane of a tail-like process. Minchin (Lankester's Zoology, Part I, London 1903,

p. 296) states that the genus is divisible into three sections. One section possess pear-shaped spores each with a single polar capsule. In the second section the two polar capsules are of unequal size. In the third section are numerous forms characterized by two polar capsules of equal size. *M. pfeifferi*, Thel., gives rise in Europe to the deadly "barbel disease." *M. cyprini*, Dofl. has been recorded from carp. As far as I have been able to ascertain, the only papers available in Calcutta which deal with the genus *Myxobolus* are the following :—

(1) Minchin, *vide ante.*

(2) Gurley. On the classification of the Myxoporidia, a group of Protozoan parasites infesting fishes. *Bulletin United States Fish Commission*, vol. XI for 1891, Washington, 1893, pp. 407-420.

(3) Ludwig Cohn. Über die Myxosporidien von *Esox lucius* und *Perca fluviatilis*. *Zool. Jahrb., Anat. Abth.*, vol. IX, text and plates, Jena, 1896, pp. 228-272.

(4) (*a*) Linton. On certain wart-like excresences occurring on the short Minnow, *Cyprinodon variegatus*, due to Psorosperms.

(*b*) Notice of the occurrence of Protozoan parasites (Psorosperms) on Cyprinoid fishes in Ohio. *Bulletin United States Fish Commission*, vol. IX for 1889, Washington, 1891, pp. 99-102 and 359-361.

Our specimens apparently do not belong to any of the species described in the above papers, but they are very closely related to the Psorosperms obtained by Linton from *Cyprinodon variegatus*. Owing to lack of literature I have been unable to determine whether our parasites represent a new species or not. Further, as our material was scanty, I have not been able to work out all the details regarding the shape of the spores. I have therefore deemed it advisable to leave our specimens unnamed, at least for the present. *Myxobolus cyprini* has been recorded from *Cyprinus carpio*, and it is quite possible that our parasites may belong to *M. cyprini*. The following details were ascertained.

*Cyst.*—Lenticular. Greatest length 1·1 mm.

*Spore.*—Length 13$\mu$ ; breadth 13$\mu$.

Capsules; 2, equal, 4$\mu$ in length, 4$\mu$ in breadth, with a very short anterior tail-like process.

Vacuole present.

As all my specimens were at once stained and mounted in balsam, I was unable to conduct re-actions with iodine, and sulphuric acid.

*Habitat.*—Sub-cutaneous intermuscular tissue of *Rasbora daniconius*, Day (=*Cyprinus daniconius*, Ham. Buch.).

### (2) A parasite encysted in the skin of Cirrhina latia.

(Plate xxvii, fig. 10).

Three specimens from Mr. Mitchell, Srinagar, Kashmir, September, 1914. Mr. Mitchell stated that such diseased fish were fairly plentiful. Other genera or species affected were not defined.

One fish measured 77 mm. long and 28 mm. broad.

The size of the largest cyst found on this fish was 4 mm. × 2·5 mm., and that of the smallest was 1·25 mm. × 1 mm. There were 7 cysts on one specimen distributed as follows:—

A. (1) Behind junction of upper and lower left lips.
(2) One mm. behind left eye.
(3) Ten mm. behind base of left pectoral fin.
(4) Three mm. behind base of right pectoral fin.
(5) Near posterior extremity of right pectoral fin.
(6) Anterior and a little to left of anus.
(7) Four mm. in front of anus.

B. This fish measured 89 mm. long and 18 mm. broad. The positions of the cysts were as follows:—

(1) Under left eye.
(2) Above right eye.
(3) Between the branchial apertures.
(4) Near posterior extremity of left pectoral fin.
(5) One and a half mm. posterior to base of left pectoral fin.
(6) Two mm. behind left eye, near middle line.
(7) On the right side of the dorsal fin.
(8) At the base of the caudal fin on the right side.
(9) On anal fin.
(10) Anterior to anus.
(11) Near middle of right side of body-wall.
(12) Eighteen mm. anterior to base of caudal fin, on the left side.
(13) Twenty-nine mm. anterior to base of caudal fin, on the left side.
(14) Ten and a half mm. posterior to right eye.
(15) Mid-ventral line, between mouth and anus.

In every case the cysts were situated in the epidermis and were covered by scales. No cysts were found in the muscles. The wall of one cyst was 1·1 mm. thick and was densely pigmented with black. To the naked eye the cysts appeared of a dark steel-grey colour, due to the unpigmented covering of scales and epidermis. The wall of the cyst was tough and fibrous, and, as we have already noted, densely black.

The cysts contained Cercaria of a milky-white colour. They measured ·7 mm. long and were bent upon themselves. The fish were not well preserved and the Cercaria were of a pasty consistency which did not allow of a careful examination of their anatomy. One sucker, however, appeared quite distinct. It is, of course, impossible to state the probable identity of the adult species represented by these immature forms. Similar cysts and parasites have been recorded by Linton from a "cunner", *Tautogolabrus adspersus* (*Bull. U.S. Fish Comm.*, Washington

1889, page 296, pt. 40, figs. 76-81), and by Ryder (*Bull. U.S. Fish Comm.*, 1884, pages 37-42).

The 'cunner' however is a marine fish of the Wrasse family, and it is unlikely that our parasites are identical either with those obtained by Linton or Ryder.

Hofer (*Handbuch der Fischkrankheiten*, München, 1904) describes a number of similar cysts from European fresh-water fishes and classifies them as *Holostomum cuticula*. It is quite possible that our larvae belong to the same species.

If these encysted immature forms of Trematodes are actually the young of *Holostomum cuticula*, it is almost certain that the adult forms will eventually be found in the intestine of fish-eating birds. The two species of fish infected are both very small and would be easily available and readily eaten by such birds.

### (3) Cercaria in skin of Nuria danrica.

(Plate xxvii, fig. 9).

Eight specimens presented by Mr. J. Taylor, Angul, Orissa, 4-v-14. All these fish (which are known in Bengal as "danrika") were very heavily infected. In the largest fish, which measured 36 mm. in length, 27 cysts were counted scattered all over the body. The smallest fish measured 21 mm. and 18 cysts were counted on this specimen. The older cysts were black pigmented, but the pigmentation was not nearly so dense as in the preceding form. The capsule was very delicate and easily ruptured. The amount of black pigment that was present varied, but was never very great. In two very young larval forms, which were removed from the gills, no pigment was present. In slightly older stages only a little pigment was observed, whilst in the largest and oldest forms obtained the pigment was never sufficiently abundant to obscure the larval cyst.

The largest cyst observed was oval and measured 1·1 mm. by ·9 mm. The larva only occupied about one-half the interior space of the capsule. It measured ·4 mm. and was folded upon itself. What appeared to be a sucker was discernible in the older forms.

It will be obvious that these larval forms differ from those obtained from *Cirrhina latia* in being younger and much smaller. Whether or not they are identical with those found on that species remains to be determined.

### (4) Cysts from the skin of Nuria danrica var. grahami.

(Plate xxvi, figs. 5, 5*a*, 5*b* and 5*c*).

Champadanga, R. Damodar near Calcutta, July, 1913.

This fish, which only measured 17 mm. long, was caught along with the young of a number of carp, *Ambassis* spp., and *Barbus* spp.

Three specimens were obtained having black cysts in the skin. In one specimen there were 7 cysts, in another 13 or 14, and in

the third there were over 20. The cysts were distributed generally over the body and were situated in the epidermis. They were surrounded with dense black pigment. On opening the cyst a milky-white larva was obtained which measured ·7 mm. long and ·5 mm. broad. This larva was enclosed in a thin, but pigmented sac, which was unattached and easily removed. Figures of the parasite are given on plate xxvi, figs. 5*a*, *b* and *c*. There was an outer, somewhat egg-shaped membrane, which was tough and transparent. The contents of this membrane were disposed towards one pole. A few cells in an active state of division were observed, towards the pole. The larva is evidently too young to admit of certain identification.

It is probable that the adult of this parasite will be found in fish-eating birds as its host is commonly eaten by them.

### (5) Encysted Cercaria in the superficial muscles of Labeo rohita and Catla buchanani.

(Plate xxvi, fig. 4).

Locality.—(I) *Labeo rohita* and *Catla buchanani* from Rajmehal, Bihar, India, October, 1913.
(II) *Labeo rohita* (other specimens). No history.

The cysts were smaller but similar in outward appearance to those found in *Cirrhina latia*. They were, however, situated in the superficial muscular layer. The two suckers were prominent. At present, the identification of these larval forms is impossible.

Their occurrence in the muscular tissue of these fish is a fact of considerable importance. These two species of carp are the two most important food-fishes in Bengal and they frequently attain a weight of over 25 lbs. The fact that the larvae occur in the muscular tissue and not in the skin, means that they are not removed during the ordinary process of cleaning, prior to the fish being placed on the table. It is true that if well cooked, the larvae are destroyed. Even if not destroyed by cooking we have no information at present as to whether these larval forms mature in the human intestine, or not.

In a previous paper (*Rec. Ind. Mus.* vol. IX, part II, June, 1913) I called attention to the fact that the rare Trematode, *Gasterodiscus hominis*, Lewis and McConnel, has been recorded twice from man in Calcutta. It is quite possible that the larval form of this Trematode may occur in the skin of fish. In this connection it is to be remembered that fish is one of the staple articles of food in Bengal.

Although I have examined several thousands of marine fish during an experience of roughly six years on the Ceylon Pearl Banks, I have never found either Trematodes or Sporozoa in the skin.

### (6) Carcinoma of the Thyroid in rainbow trout (Salmo irideus) from Naini Tal.

(Plate xxvi, figs. 1 and 2).

During the early part of 1914, the Dy. Conservator of Forests. Naini Tal, United Provinces, India, in a letter to me, stated that numbers of rainbow trout (*Salmo irideus*) were dying in the hill-waters in the vicinity of Naini Tal. I requested him to forward to me specimens of the dead fish, preserved in spirit. In all, I received 13 specimens. The largest measured 15½ inches and the smallest 10 inches. There were 4 or 5 females with ripe eggs. No external or internal parasites were discovered. Three of the fish had a small abrasion on the body. These wounds, however, were occasioned during packing and transit, and were in no way connected with the death of the fish. Out of the 13 fish sent, tumours were found on the gills of three. Excepting the tumours just mentioned, the fish appeared normal and well fed. The location of the tumours was as follows :—

(1) *A small trout* 10 *inches long.*—The tumour was situated in the gills, on the convex (postero-ventral) edge of the gill-arches on the right side. Only one tumour was present (plate xxvi, fig. 2). It measured 17 mm. long, 9 mm high and 4 mm. thick. The outer surface of the gills in the vicinity of the tumour was slightly pigmented with black. The tumour did not involve the bony branchial arches, but only the gill-filaments in the vicinity, *i.e.* the tumour replaced the gill-filaments. The gill on the last branchial arch was the only one not involved.

(2) *A large trout* 15½ *inches.*—Two tumours, one in each branchial cavity, visible ventrally as coarsely nodulated or lobated masses in the anterior extremity of each branchial chamber. The one on the right side was larger than that on the left. The measurements were as follows :—

Large tumour—long 20 mm., high 13 mm., thick 11 mm.
Small tumour— ,, 14 ,, ,, 7 ,, ,, 5 ,,

The external gill-filaments on the right side were only slightly affected. The corresponding gill-filament on the left side was not involved.

(3) *A medium-sized fish.*—Two tumours situated as in (2), both of the same size and measuring 20 mm. long, 14 mm. high and 15 mm. thick.

The latter tumours were situated at the anterior extremity of the branchial chamber just below the eye, and were sufficiently bulky to project into the buccal cavity. The tumours consisted for the most part of a yellow-white cheesy substance enclosed in a thin, but slightly tough, fibrous capsule. The tumours were not pedunculated, but were supported by the capsule, which was attached at various places to the anterior wall of the branchial chamber. Posteriorly the cyst was free. Anteriorly the two tumours were in contact in the centre line. The tumours consisted entirely of the caseous substance referred to above.

Unfortunately only spirit specimens were available and hence I have been unable to make observations on fresh material. Sections were made from one of the larger tumours. These tumours are undoubtedly due to a disease of the thyroid variously known as gill-disease, thyroid tumour, endemic goitre and carcinoma of the thyroid. The disease was first noted in 1883 by R. Bonnet (1)[1]—in *Trutta lacustris* obtained from a hatchery in Torbole on the Gardasee. The disease accounted for the death of 3000 fish.

The first investigator to define the tumour as Carcinoma was Scott (9) who found it in *Salmo frontinalis* from ponds at Opoho belonging to the Dunedin Acclimatisation Society, New Zealand.

In 1902, Marianne Plehn (8) recognized that the tumours were due to a disease of the thyroid gland. In 1903, L. Pick (*7b*) described the disease fully. Gilruth (3) in the reports of the New Zealand Department of Agriculture (Veterinary Division, 1901 and 1902) described a similar disease in *Salmo salar* as "Epithelioma affecting the branchial arches of Salmon and Trout." Later, this author recorded the disease from *Salmo irideus*.

L. F. Ayson, Chief Inspector of Fisheries, New Zealand, stated in a letter to Gilruth that he had noticed the disease in *Salvelinus frontinalis* in 1890. In 1908, Jaboulay (5) reported the disease in six trout from Thonon. Up to the present, five species of fish from Europe and 21 species from America have been recorded suffering from the disease. In America the disease appears to have been known for a long time although not described until 1909, when Dr. Gaylord read a paper on "an epidemic of cancer of the thyroid in brook trout" before the American Association for Cancer Research. The initial investigations into diseased thyroids in the Salmonidae by the American Association for Cancer Research were due to the papers on the subject which had previously appeared by Plehn and Pick.

The Association continued to make extensive observations on the disease, and an excellent and exhaustive report on the subject was published in the Bulletin of the Bureau of Fisheries vol. XXXII, 1912 ("Carcinoma of the Thyroid in the Salmonoid fishes," by Harvey R. Gaylord, etc., Doc. No. 790. Issued April 22, 1914). To these authors I am indebted for most of the details set forth in the present paper. In Salmonoid fishes the thyroid is a more or less diffuse, unencapsuled organ, distributed along the course of the ventral aorta. The gland, however, appears to be much more diffuse in domesticated trout than in wild trout. Gudernatch states that in wild species the gland may extend into the gill-arches and even into the muscle bundles of the isthmus. This circumstance serves to explain the fact that tumours may be found in places as far removed as the jugular pit and the rectum. The disease is universal where trout are artificially cultivated, and in certain hatcheries it may become endemic. Artificial cultivation is obviously a predisposing factor since the disease is rare in nature.

[1] These numbers refer to the literature cited on p. 320.

Healthy wild fish placed in hatcheries where the disease is endemic soon become affected. The first symptoms of disease of the thyroid is simple hyperplasia usually marked in living specimens by a redness of the throat ("red floor") near the second gill arches, and caused by an increase in the blood supply to the thyroid, and to hyperaemia of the adjacent tissues. This condition of simple hyperplasia passes gradually into the stage of visible tumour. Various structural types of infiltrating tumour are known amongst Salmonoid fishes, including the alveolar, solid, tubular, papillar and mixed, and the investigations of workers in America show that the tumour is of a true malignant nature.

The cause of the disease has not been definitely determined, but it is known that trout fed on animal proteid food, in an *uncooked* condition, are more heavily infected than those fed on *cooked* animal proteid food. The crowding together of fish in confined spaces, and other generally unsatisfactory hygienic conditions also favours the spread of the disease.

General insanitary conditions alone are, however, insufficient to account for the phenomenon. A specific living organism is suspected, although no such organism has been isolated up to the present. In America it was found that scrapings from the inner surface of the wooden tanks in which diseased fish were kept, if suspended in water and administered to certain mammals, produced in such animals a definite condition of goitre, and it was accordingly believed that this agent was the cause of the disease amongst the fish in the tank.

It was further shown that by boiling the water the effective agent was destroyed. The disease does not appear to be directly transmissible from one individual to another.

Some species of the Salmonidae are practically immune from the disease, and in other species spontaneous recovery frequently occurs. Especially is this the case if the diseased fish are removed to natural conditions and allowed to feed on natural food. Moreover the disease is directly susceptible to treatment. At all times the normal thyroid contains traces of iodine. During hyperplasia the proportion of iodine appears to be reduced. Occasionally human goitre reacts favourably to treatment with iodine. In all stages of its growth the tumour in fish is favourably affected by solutions of iodine as well as by those of mercury and arsenic. It is thus possible, in a limited way, to treat these diseases in hatcheries and in limited water-areas. At the same time it will be obvious that the object of fish culturalists should be to prevent the disease rather than to effect its cure.

A tumour, apparently of a similar nature, is recorded by Williamson (Fisheries Scotland, Scientific Investigations for 1911, Glasgow, 1913, page 23) in the following words.

"*Tumour in the pharynx of a Salmon caught in the sea.*"

"It was found loose in the gill cavity after the fish had been killed by a blow on the head. Two of the gills were found to be

damaged. There was a sinus in the free edge of the gill. It is not clear how the tumour was attached, but the connection was apparently a slender one. The tumour is lobulated, fibrous in structure, without any distinct lamina."

Simple hyperplasia of the thyroid has also been recorded in pike, bass, and occasionally in herring, by Marine and Lenhart.

During an experience of about five years on the Ceylon Pearl Banks, although I had occasion to examine very many thousands of fish, in no instance did I see a case of visible tumour in any examined.

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## (7) Description of a new species of Isopod Crustacean parasitic on the Bhekti (Lates calcarifer).

### Rocinella latis, n. sp.

(Plate xxviii, figs. 12–15).

| | | | |
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| No. $\frac{9056}{10}$ | From skin of *Lates calcarifer*, 15-ii-1915. | Diamond Harbour (R. Hughli), near Calcutta. | T. Southwell. |

All the specimens caught were males. The head projects well beyond the basal joints of the first and second antennae as a broadly rounded plate, convex from above. The first peraeon segment is longer than the rest. The first five segments of the pleon are a little narrower than those of the peraeon. The telson is slightly narrower than the preceding segments of the pleon.

The eyes are large, well separated, and situated laterally. They extend on to the ventral surface.

The bases of the first and second antennae are hidden in dorsal view by the frontal lamina which extends well beyond them. The first antennae are much stouter and much shorter than the second antennae. The flagellum is 8-jointed and terminates abruptly. The last joint extends to the middle of the first peraeon segment. The second antennae are, as noted, slender.

The flagellum consists of 10 (possibly 11) joints and it extends to the posterior extremity of the first peraeon segment. In length it exceeds that of the first antennae by its terminal 3 joints. The basal joints of the antennae are not distended.

The upper lip is crescentic, thin and membranous.

The mandibles have the palp somewhat elongated.

The first three pairs of legs are prehensile and have long and evenly curved dactyli, the extremities of which are of a dark brown colour in most specimens. The propodus is broad and crested and is armed with about 8 long, pointed, comb-like spines. There is a single elongated spine at the distal and exterior angle of the merus. The spines on the propodus of the first pair of legs are not quite as well defined as those of the second and third pairs.

The four gressorial legs are very similar to the first three pairs of legs, but a little more slender. The dactylus bears two spines near its base. The propodus bears 8 spines, but the spines are not borne on a crest, *i.e.* the propodus is not nearly so broad as is the case in the first three pairs of legs. The carpus bears four spines and the merus two. All these spines are situated on the internal surface. The last pair of legs is slightly smaller than the rest.

The largest specimen measured 14 mm. long and the greatest breadth was 4·5 mm.

In young specimens the whole surface is marked with minute pigment spots, hardly visible to the naked eye. In adults, however, the pigment consists of three very narrow longitudinal bands, one on each side and one running along the centre of the carapace.

This latter band spreads out between the eyes. Each band of colour consists of very numerous pigment spots.

The Bhekti on which these parasites occurred was caught in the vicinity of Diamond Harbour in the Hughli river near Calcutta on February 15, 1915. When placed on deck alive, some three dozen parasites were found to be moving over the skin of the fish. A few left the host and were picked up from the deck of the ship. I have never seen these parasites on any Bhekti in the markets and I believe that after the fish are removed from water the parasites quickly drop off.

The parasites are Isopods of the tribe Flabellifera. They are included in the family Aegidae and fall in the genus *Rocinella*, Leach, 1818. The characters of this genus are as follows :—

"Form of body resembling that of *Aega*, though being somewhat less compact and more depressed. Metasome generally less broad, with the terminal segment rounded off at the end and finely ciliated. Eyes well developed with very large and conspicuous cornea. Antennae slender, the superior ones much shorter than the inferior, and with the basal joints not expanded. Epistomal plate very small and narrow. Mandibles considerably produced, with the cutting edge expanded inside to a linguiform lamella (molar expansion); palp well developed with the basal joints much elongated. Maxillae nearly as in *Aega*. Maxillipeds with the palp composed of only two joints, the terminal one armed with strong recurved teeth. The three anterior pairs of legs having the propodus more or less expanded and armed inside with strong spines, dactylus forming a very large and evenly curved hook. The four posterior pairs slender, resembling in structure those in *Aega*. Pleopoda and uropoda normal" (Sars).

The conspicuous cornea, the non-expanded base of the antennae, the nature of the propodus in the three anterior pairs of legs, the evenly armed dactylus on the three anterior pairs of legs, and the four-jointed maxillipeds, distinguish the parasite as belonging to the genus *Rocinella*. An outstanding feature of the species is the broad elongated head-shield which extends well beyond the bases of the two pairs of antennae.

The specimens have been deposited in the Indian Museum.

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### (8) Argulus foliaceus, Linnaeus, from the skin of Labeo rohita (Rohu).

(Plate xxviii, figs. 16–18).

Agricultural Farm tank, Siripur, Bihar, India. August 20, 1913.

During the year 1913 I was engaged making observations with reference to the breeding habits of Indian Carp. For this purpose three tanks were dug in the Agricultural Farm at Siripur. The measurements of the three tanks were the same, namely, 50 ft. in length, 37 ft. in breadth and 7 ft. in depth.

These tanks were situated in a line at right-angles with, and very close to, a neighbouring stream, from which they received water.

In addition, it was found that a small spring of water existed in the middle tank. The tanks were only separated from each other by a narrow bund and they were in connection with each other by means of a pipe running through each bund near the surface. The tank which we will consider as No. 1 was situated nearest to the stream, from which it was distant only about three or four yards.

About eighteen mature specimens of *Labeo rohita*, both males and females, were placed in these three tanks during the latter part of July. It was found that large numbers of frogs entered the tank nearest to the river. In order to exclude frogs from this tank a matted fence was erected all round it. About the middle of August, Mr. Mackenzie, the Superintendent of the Agricultural Farm, noticed that the fish became sluggish and floated on the top of the water. On examining one or two it was found that they were covered with external parasites. These were preserved in spirit and forwarded to me. The steps taken by the Farm Superintendent to remedy the disease were as follows:—First, all the fish were captured and scraped as clean as possible. The fence matting was then removed giving free access to frogs, etc. Lastly, an upright bamboo was erected in the centre of the pond. The Farm Superintendent, whose observations and statements are thoroughly reliable, states that the fish proceeded forthwith to rub themselves against this bamboo. There were no deaths.

About the end of September all the fish were captured and killed and were then found to be perfectly clean; not a single parasite was found. The fish present in the second and third tank were not affected. I have since ascertained that extensive deaths amongst carp in tanks due to "external parasites" have occurred, within the last four years, in the districts of Mymensingh and Murshidabad, and I have no doubt that the parasite causing these diseases was identical with the one obtained from Siripur. The forms examined by me are undoubtedly *Argulus foliaceus*, Linn., and have been recorded as external skin and gill parasites

from a large number of European freshwater fishes, such as *Tinca vulgaris*, *Gasterosteus* spp., *Cyprinus carpio*, *Esox lucius*, *Perca fluviatilis*, *Salmo trutta*, etc., and even from the tadpoles of frogs.

The parasites attach themselves to their host by means of two strong suckers which are the modified anterior maxillipeds. Like other parasitic Copepoda they suck the blood of their host. This is effected by means of a proboscis or dart which is evertable, and which is formed by a modification of certain of the mouth parts. The posterior maxillipeds are also modified for the purpose of clasping, and thus enable the parasite to cling to its host. In addition, the basal joints of the anterior antennae are modified for a similar purpose. The parasites lie inserted between the scales of the fish, with their long axis parallel to that of the host. They are, however, by no means stationary and fixed, but may be seen to skip about over the fish's body as if in search of a better position. During the breeding season they voluntarily leave the body of the fish and swim about actively in the water by means of four pairs of swimming legs. Unlike other Copepoda, the eggs, which are laid in gelatinous strings of two rows, are usually shed into the water and not carried about by the female. On being shed, the gelatinous covering hardens and thereby firmly attaches the eggs to the object on which they were deposited. Observations made in Europe show that the parasite breeds three times a year. Under these circumstances it is clear that there are three occasions each year when infected fish may free themselves from their parasites. The development of the egg occupies about a month.

Wilson states that the newly-hatched larvae have the general characters of the adults and on hatching begin to swim at once. The nauplius, metanauplius and early cyclops stages are passed inside the egg. After a few moults they become adult. Certain species of *Argulus* appear to be capable of living on both fresh and salt water fishes. This circumstance, together with the fact that the parasites can swim freely and frequently leave their host, accounts for the fact that the same species of parasite is often found on different species of fish.

As far as I am aware this is the first definite record of this parasite in India. In April, 1910 Mr. S. W. Kemp, Senior Assistant Superintendent, Indian Museum, inspected a tank near the palace of the Maharaja of Cossim Bazar in which diseased fish (Rohu, *Labeo rohita*) were living. He found that the disease was associated with scanty food, and the presence of large numbers of leeches and parasitic Copepoda, the latter belonging to the genus *Argulus*.

On April 17th, 1911, Dr. Annandale obtained a free-living *Argulus* from the Atrai river, near Siliguri, at the base of the Himalayas (Jalpaiguri District, Bengal). I have examined the latter specimen and found it to be a very small male *Argulus foliaceus*, Linn. Unfortunately I have been unable to obtain the specimens collected by Mr. Kemp, but it is very probable that they also belong to this species.

It is significant that the parasites, both at Cossim Bazar and Siripur, only attacked *Labeo rohita*, although other species of fish, such as *Catla buchanani* and *Cirrhina mirgala*, were living in the same tank at Cossim Bazar, and in the next tanks at Siripur. The mortality amongst tank fish in particular, due to the presence of this parasite, is, in all probability, fairly extensive in Bengal. In nature, however, the parasites are rarely dangerous. The practice of stocking tanks with fish—so prevalent in Bengal—undoubtedly favours conditions under which the parasite thrives. It is known that in Europe the parasites themselves are eagerly devoured by roach, dace and bream. The presence of such fish therefore tends to check the distribution of the parasite and thus to protect other fish from their attacks. It seems possible that in our tanks at Siripur, the frogs, when allowed to enter, also devoured the parasites, but no direct observations were made in this connection, and hence we have no certainty that such was really the case.

The family Argulidae, Muller, belongs to the sub-order Branchiura, Thorell, and to the order Copepoda, Muller. It contains three genera *viz. Argulus*, *Chonopeltis* and *Dolops*. In the former two genera the first maxillipeds are modified into sucking discs and in the latter genus sucking discs are absent. The genus *Argulus* contains about thirty-two species of which only three are European, the rest being found in American waters. The majority of the forms are marine. The various species exhibit but little trace of degeneration, a circumstance one would expect considering the alternation which exists between temporary parasitism and a free life. The males differ but slightly from the females but are considerably smaller.

Our specimens, of which we have over 200, are small, the extreme length of the largest female was 3·2 mm. and the greatest breadth was 2·2 mm. The carapace is elliptical. The posterior sinus extends nearly half-way up the length of the carapace. The abdomen is almost square and about $\frac{1}{4}$ the length of the body. The suckers are small, placed quite anteriorly and well separated from each other. Their diameter is almost ·4 mm. The basal plate of the posterior maxillipeds is triangular in shape with three well defined, sharp, rectangular teeth. All the swimming legs extend well beyond the edge of the carapace. In the male the abdomen is much longer and narrower than in the female, and the sinus is narrow, sharply cut, and deep.

The specimens have been deposited in the Indian Museum and are numbered $\frac{2054}{10}$.

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## (9) Amphilina magna, n. sp. from the coelom of Diagramma crassispinum.

Group **CESTODARIA**, Mont., 1892.

= *Cestoidea monozoa*, Lang.
= *Cestodes monogeneses*, V. Ben.
= *Atomiosoma*, Monticelli, 1892?

Cestodes in which the animal consists of a single segment, containing a single set of reproductive organs. In addition to the male pore and female (vaginal) pore, there is a third aperture, that of the uterus (birth-pore). The apparatus by which fixation is effected, consists usually of a single sucker, but presents considerable variation in form, as well as in disposition, with regard to the genital pores.

Family Amphilinidae, Braun, 1883.

Oval or leaf-shaped, without a distinct "head", but with a single small acetabulate sucker at one end.

Genus **Amphilina**, Wagener, 1858.

"Body flat. Long egg-shape to leaf-like. Anterior and posterior ends pointed. Dorsal surface more arched than ventral surface. Skin with a net pattern caused by regular pit-like depressions. Anterior extremity usually with a pit, deep, or otherwise, according to the degree of contraction. This extremity may also present the appearance of a papilla or glandiform snout. On this papilla numerous one-celled glands occur, with long excretory ducts. The excretory system consists of anastomosing vessels with pore posterior. Testes numerous. Cirrus-sac absent. Ovary and reproductive aperture posterior. Opening of vagina a little way from posterior extremity, marginal or on surface. Uterus a long N-shaped canal, first running forward, then turning round and running posteriorly, then again curving round and running forward" (Wagener).

### Apmhilina magna, n. sp.

(Plate xxvii, figs. 6-7).

Z.E.V. $\frac{6046}{7}$ Coelom of *Diagramma crassispinum.* Pearl Banks, Ceylon. T. Southwell.

Three specimens. Two damaged, one perfect.

A description of the superficial characters of this worm was given by me in the Ceylon Marine Biological Reports, Vol. VI, Jan. 1912, page 273, and this I reproduce here.

"During the examination of a number of specimens of *Diagramma crassispinum*, three specimens were found to (each) contain a most remarkable free living parasite in the coelom. Un-

fortunately I have not had time to make a careful examination of this parasite, and I am at present uncertain of its strict zoological position..... In the living condition it measured 15 inches long and $1\frac{1}{8}$ inches broad. It was quite flat, and had a thickness of $\frac{1}{16}$th inch. The preserved specimens, of which I have 3, measure $9\frac{1}{2}$ inches long, $\frac{3}{4}$ inch broad, and are about $\frac{1}{8}$ inch thick. The extremities are rounded and terminate in a minute, acute point. At one extremity there is a minute sucker-like aperture situated centrally, whilst at the other extremity there is a similar but slightly larger aperture situated laterally. This latter aperture appears to open to the interior of the worm. The edges of the worm are straight and parallel. A pair of narrow blackish tubes run along the lateral margins, one on each side. Down the centre of the worm, and stretching from one extremity of the worm to the other, is an opaque milky-white mass $\frac{1}{4}$ inch broad. On each side of this mass there are a series of black coiled tubes, $\frac{1}{16}$th inch in diameter disposed in bunches, also running the entire length of the worm, but situated for the most part on one side. No other apertures could be detected. In consistency the worm is that of a stiff (milky-white) jelly, (in formalin)."

For assistance in working out the anatomical details of this worm I am indebted to Dr. Ekendranath Ghosh, L.M.S., M.Sc., Assistant Professor of Zoology in the Medical College, Calcutta.

The following measurements of the specimens (preserved in formalin) have been taken recently :—

| | Length. | Breadth. |
|---|---|---|
| Specimen I | .. 250 mm. .. | .. 20 mm. |
| ,, II | .. 180 ,, .. | .. 14 ,, |
| ,, III | .. 160 ,, .. | .. 15 ,, |

The testes lie scattered about through the parenchyma. At a point about 15 mm. from the posterior extremity, the paired vas deferens unite in the middle line, and open by a minute pore 1 mm. from the posterior extremity.

The germarium is situated in the middle line 15 mm. from the posterior extremity. It is 7 mm. long and 3·5 mm. broad. Immediately posterior to it are the paired follicular shell-glands. These are each 3 mm. long and together are 3 mm. broad. The vaginal pore is 2 mm. from the posterior extremity. The vitelline glands are paired, linear, and cylindrical, one on each side, near the lateral margins. They extend the whole length of the worm. At 4 mm. from the posterior extremity of the worm their ducts curve towards the vagina and open close to the shell-gland. The uterus is a long convoluted tube having exactly the same form as that figured for *A. foliacea*. It opens by a minute pore, which is situated at the base of the small anterior end of the worm. In this respect it agrees with *A. liguloidea*, Diesing, and differs from *A. foliacea* (Rud., 1819). It differs, however, from *A. liguloidea* in the absence of a vagina, anterior to the germarium. The situation

of the male and the vaginal pores also resemble that of *A. liguloidea*, and differs from that of *A. foliacea*.

No hooklets were observed on the penis of our specimens. The eggs are large, measuring almost ·1 mm. In shape they resemble half a sphere, the flat surface of which has became concave. No filament was observed. Compared with other known species of *Amphilina*, our specimens are enormous, as will be seen from the following table:—

| | Length. | Host. |
|---|---|---|
| *A. foliacea* | .. 60 mm | .. *Acipenser* sp. |
| *A. liguloidea* | .. 80 mm. | .. ? |
| *A. neritina* | .. 18 mm. | .. *Acipenser* sp. |
| *A. magna* | .. 250 mm. | .. *Diagramma crassispinum*. |

The nearly related genus *Wageneria* contains the following species:—

*W. proglottis* (Wag., 1854), Mont., 1892.
*W. aculeata*, Cohn, 1902.
*W. porrecta* (Lühe), Cohn, 1902.
*W. impudens* (Crep., 1846), Cohn, 1902.
*W.* sp. Lühe, 1902.
*W.* sp. (Mont.)?

Unfortunately I have been unable to compare my types with descriptions of any of the above species of *Wageneria*, as literature was not available in India. The type of *Amphilina magna*, n. sp. is deposited in the Indian Museum.

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## (10) Syndesmobothrium filicolle, Linton, parasitic in the flesh of Harpodon nehereus ("Bombay duck") from Diamond Harbour.

(Plate xxvii, fig. 8).

| | | | |
|---|---|---|---|
| Z.E.V. $\frac{6869}{7}$ | Flesh of *Harpodon nehereus.* | Diamond Harbour, 17-ii-1915. | T. Southwell. |

The original description of this parasite was given by Linton in the Report of the Commissioner of Fish and Fisheries for 1887 (published 1891, Washington), page 861, plate xv, figs. 2 and 4. The description was from a single specimen and the details given are so meagre that the identification of the parasite is attended with a little uncertainty. The adult form was obtained by Linton from the spiral valve of *Trygon centrura* at Woods Hole, Mass. *Encysted* forms were also obtained by Linton from various species of Teleosts such as *Pomatomus saltatrix*, *Cybium regale*, etc.

The present writer also obtained the same parasite on the Ceylon Pearl Banks from the intestines of *Cybium guttatum* (Seer fish) and *Chorinemus lysan* (Southwell, Ceylon Marine Biological Reports, Part VI, page 269, plate ii, figs. 16 and 17. Colombo, 1912).

The flesh of *Harpodon nehereus* (when alive) is transparent, resembling that of a jelly-fish. The cysts being milky-white were easily discernible with the naked eye. Many cysts were 16 mm. long and the smallest obtained was 4 mm. They were all roughly tadpole-shaped, but the "tail" portion varied greatly in length and thickness. When removed, the cyst moved about actively. The parasite itself could be seen under a low power as a more densely milk-white spot in the head of the cyst. Over 80 cysts were taken from the flesh of a single fish which measured $3\frac{1}{2}$ inches long.

*Harpodon nehereus* was very plentiful in the river between the sea and Diamond Harbour; in the vicinity of the latter place it was scarce and ten miles further north entirely absent. Every fish caught was infected. As far as I am aware, this is the first record of a cestode parasite occurring in the flesh of any fish, east of Suez. The parasite becomes adult in the larger species of *Trygon* and *Hypolophus*. In other words when rays and skates eat the infected Bombay duck, the larval parasites in the latter become adult tapeworms in the intestines of the rays. The parasites do not inhabit the human intestine and hence there is not the slightest danger of human beings becoming infected by eating the infected fish.

Diamond Harbour is on the river Hughli and is situated about 40 miles from the sea.

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## (11) Disease in the eye of Holocentrum rubrum.

(Plate xxviii, fig. 11).

The opportunity is taken of recording in this paper the occurrence of a disease of the eye in *Holocentrum rubrum*. This fish is a marine species.

I noticed the disease in question in January, 1915 during a visit to the Marine Aquarium, Madras, where the fish was then living in one of the tanks.

I am indebted to Dr. J. R. Henderson, Superintendent of the Madras Museum, for kindly presenting the specimen. Dr. Henderson suggested that the disease was a glaucoma, probably caused by an accident whilst the fish was being captured at sea or during its transference to the aquarium.

Since the above paper was written I have obtained very large cysts containing young Trematodes from the flesh of *Ophiocephalus striatus*, *Ophiocephalus marulius* and *Ophiocephalus gachua*. Smaller cysts, apparently containing Cercaria, have also been obtained from the flesh of *Saccobranchus fossilus* and *Trichogaster fasciatus*. In *Saccobranchus fossilus* over 140 cysts were counted in the flesh of a small specimen.

The infected fish were obtained from *beels* in the Khulna district. I hope to describe the parasites in a future paper.